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SANTO DOMINGAN PALEONTOLOGICAL EXPLORATIONS

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In the early seventies, forty-four years ago, Professor William Gabb published the results of his topographical and paleontological explorations in Santo Domingo.¹

Since that time no paleontological researches have been made on the island until the writer's expedition up the Yaqui Valley in 1916. Fully illustrated and detailed accounts of the latter have been published in *Bulletins of American Paleontology*,² but a comparative and historical sketch of the subject and a statement of the present status of our knowledge may perhaps be deemed of interest.

Before the time of Gabb, in 1849 and 1850, paleontological collections had been made by Colonel Heneken, of the British army. This gentleman, who was the pioneer, was stationed for a time at the fort at Monte Cristi, and his interest was awakened by finding the exquisitely preserved fossil shells at various places up the valley of the Rio Yaqui and its southern tributaries. In the interval between revolutions and military duties he obtained two collections of fossils which he sent with explanatory notes to the Geological Society of London. For many years the fossils were kept in the rooms of that Society; but lately they have been handed over to the natural-history division of the British Museum.

The shells Heneken collected were described by Sowerby, and interesting deductions on their relationships and affinities were written by Moore. Both Moore and Sowerby were quick to see their resemblance to the fossils of Dax in the Bordelais region of

¹ William Gabb, *Trans. Amer. Phil. Soc.*, XV (1873).

² "Santo Domingo Type Sections and Fossils," *Bull. Amer. Pal.*, V, No. 29 (March-April, 1917), 251 pp., 39 pls.; No. 30 (May, 1917), 45 pp., 3 pls.

France, and pronounced them of Miocene age.¹ They raised the question, of late years also set forth by Dall, whether more than one formation was represented. They called attention to the resemblance of certain of the fossils to the recent deep-sea and Pacific forms. Indeed, the brief article of Moore shows a highly philosophic interpretation of the data. Later, in 1872, Dr. Guppy of Trinidad, on a trip to London, reopened the Heneken collection, made a number of excellent illustrations, and described some of the specimens which further study had showed to be new.²

Gabb agreed with these pioneers in assigning a Miocene age to the fossils from the Yaqui Valley, but emphatically denied the possibility that more than one formation was represented, coinciding in this with Heneken. Gabb regarded the entire valley as made up of fossiliferous beds of late Miocene time. The belief that this constituted a stratigraphic unit led him to disregard entirely localities and zones in collecting, and his otherwise fine collections are very seriously marred by having been labeled solely: "Miocene, Santo Domingo."

Our 1916 expedition was undertaken with the express object of determining the exact stratigraphic sequence. The party consisted of the writer, Mr. Karl Paterson Schmidt, and Mr. Axel Olsson. Despite the dangers of the revolution led by Desiderio Arias, we succeeded in collecting over four hundred species of molluscs, many corals, bryozoa, foraminifera, echinoderms, and crustacea. The molluscs are at present in the museum of Cornell University, while all the other groups were presented to the United States National Museum in recognition of the very kind assistance given by Dr. Vaughan and his associates in identifying them for us. About a third of the molluscs were new species, and, as practically none of Gabb's species had been figured, every effort was made to illustrate all the species as beautifully and accurately as possible, more than five hundred and eight figures being given in the writer's report in the *Bulletins of Paleontology*.

As a result of these faunal studies and of the very careful sections obtained along the various rivers where the fossiliferous

¹ See *Quart. Jour. Geol. Soc.*, London, 1850, 1853.

² *Ibid.*, 1872.

beds were found, I believe that three formations¹ are represented, named from their characteristic fossils and given in ascending order: the *Orthaulax inornatus*, the *Aphera islacolonis*, and the *Sconsia laevigata* formations. The *Orthaulax* horizon is approximately equivalent to the Rupelian of Europe, ties up with the Tampa silex beds of Florida, and is Oligocene. The *Aphera* horizon is the Upper Aquitanian of Europe, which is Lower Miocene, and is linked with the marls of the Chipola River, Florida. The *Sconsia* horizon is the Burdigalian of Europe, which is Middle Miocene and is synchronous with the Oak Grove sands and the cross-bedded Alum Bluff beds² of Florida.

In closing the Oligocene with the Rupelian we agree with the European geologists. In this country custom varies, certain very prominent geologists continuing the Oligocene farther up because of the absence of any conclusive stratigraphic break. According to the latter view no Miocene is present in the Antilles, because it is thought that they were so highly elevated during that period that the materials deposited lie now out at sea.

There seems, however, to the writer no necessity for postulating this great change of level, and the supposition that Oligocene time in the Antilles passed on into Miocene with continuous sedimentation appears more probable.

In connection with this question of Miocene versus Oligocene age, the discovery by Dr. Sellards, director of the Florida Survey, of Miocene vertebrates in Florida is illuminating. Our conclusions of the Miocene age of the *Aphera* formation in Santo Domingo and through it of the Alum Bluff cross-bedded sands and the sands of Oak Grove were made independently of Dr. Sellards' results, with which they harmonize.

Looking back to early Miocene times we may picture to ourselves an arm of the sea running east and west in the northern part of Santo Domingo and occupying what is now the valley of the Rio Yaqui. In the shallow waters was a rich molluscan fauna, solitary and compound corals were common, crabs of various genera and hermit crabs lurked about, bryozoa incrusted the

¹ See Correlation Table, *Bull. Amer. Pal.*, No. 30, 1917.

² See the writer's drawn section, *Bull Amer. Pal.*, No. 15 (1902), p. 57.

rockweeds. A marked feature was the local distribution, certain assemblages being limited to certain coves. Univalves far outnumbered bivalves. The genera *Terebra*, *Conus*, *Drillia*, *Cythara*, *Cancellaria*, *Oliva*, *Marginella*, *Mitra*, *Strombina*, *Murex*, *Cypraea*, *Strombus*, *Cerithium*, *Pyramidella*, and *Turbanilla* abounded. Among the bivalves was a profusion of Arcas, while the genera *Chama*, *Pecten*, *Cardium*, *Protocardia*, *Chione*, *Petricola*, *Tellina*, and *Corbula* were represented by many beautiful forms. Lignitic beds, gravels, and clays were being deposited. As the Middle Miocene was ushered in the change of conditions began first to be felt by the sensitive corals, then the sluggish molluscs were affected and a large proportion of them ceased to exist and were replaced by different forms. Members of the Myrtle, Laurel, and Mimosa families grew upon the neighboring shores, with a number of woods of new species not known from elsewhere.

The Pacific element in the fauna of the Yaqui Valley is very marked in some cases. This fact that the nearest living allies and apparent descendants of certain of the fossil species are now on the west coast or in the Gulf of California might seem to indicate an Oligocene age of the deposits. But if we regard sedimentation as proceeding uninterruptedly, there is no reason why the species may not have lived on in the Antilles for some time and not suffered immediate extinction. Moreover, Dr. Vaughan has been led to suggest from the evidence gathered from fossil corals of the Californian region that a trans-Isthmian passage may have existed later than Oligocene time. This appears strengthened by Professor Harris' observations of the Pacific and Gulf of Californian affinities of the Miocene molluscan fauna of the Galveston deep well. Our Antillean Miocene is, however, entirely distinct from the deep-well Miocene faunas of Texas and Louisiana, nor has it any resemblance to the cold-water Chesapeake Miocene of Maryland and Virginia.

Certain of the fossils of the Yaqui Valley most closely resemble species now living in the deep sea. Undoubtedly, however, the fossils were shallow water in habit of life because their associates all conclusively prove this, even the foraminifera being all genera now characteristic of shallow waters. Thus indications are

furnished of a considerable number of migrations since Mid-Tertiary time from the shallows to the depths, and an illustration is given of one mode of derivation of the abyssal faunas.

The vanished land of "Antillia" delights the imagination. It has taken form under the bold and able pen of Bailey Willis, who represents it as at one time joined to Yucatan and at another to Florida. Investigations of the fossil invertebrates and comparisons of the land molluscs of Central America with those of Santo Domingo may give more probability to this ancient land. At present we only know definitely that the fossil fauna of the Yaqui Valley of Santo Domingo is most closely allied to that of Bowden, Jamaica, and also has affinities with the island faunas of Cumaná, Trinidad, and Martinique and with the Isthmian fauna of Gatun.